AMENDMENTS TO THE DRAWINGS

Please amend Figs. 2, 5, 7, 13, 15, 16, 19 and 20 in accordance with the attached replacement sheets of drawings.

REMARKS

Reconsideration of this application, as presently amended, is respectfully requested. Claims 1-20 are pending in this application. Claims 1-3, 5-13 and 15-20 stand rejected. Claims 4, 9, 14 and 19 were objected to as being dependent upon a rejected base claim, but were indicated allowable if rewritten in independent form (see page 9, Item 11 of Office Action).

Objection to the Drawings

Figs. 13 and 15 of the drawings were objected to because "Cash Control" should be -- Cache Control-- (Fig. 13) and "Acquire Cash Memory" should be -- Acquire Cache Memory— (Fig. 15). Figs. 13 and 15 have been amended in the attached replacement sheets to correct these informalities noted by the Examiner.

Moreover, applicants have noted and corrected other minor informalities in the drawings in the attached replacement sheets of drawings. Specifically, in Fig. 2, "MAITENANCE PC" 3 has been changed to --MAINTENANCE PC--; in Fig. 5, "Reminder" in steps S12 and S18 has been changed to --Remainder--; in Fig. 7, "Reminder" in steps S24 and S28 has been changed to --Remainder--; in Fig. 16, "AFTER EXPANTION" has been changed to --AFTER EXPANSION--; in Fig. 19, "FIST TIME" has been changed to --FIRST TIME--, and "AFTER EXPANTION" has been changed to --AFTER EXPANSION--; and in Fig. 20, "fot" in step S40 has been changed to --for--.

Approval and entry of the changes to the drawings are respectfully requested.

Claim Objections

Claims 1, 5, 11 and 15 were objected to for informalities. Specifically, the Examiner asserts that the acronyms RLU, RLBA, and LBA should be changed to "RAID Logic Unit," "RAID Logic Block Unit," and "Logic Block Address," respectively, in claims 1, 5, 11 and 15.

Claims 1, 5, 11 and 15 have been amended to incorporate changes similar to those suggested by the Examiner. In particular, in the claims, RLU has been changed to "RAID logical unit"; RLBA has been changed to "RAID logical block unit"; and LBA has been changed to "logical block address."

Withdrawal of the objection to the claims is respectfully requested.

Claim Rejections-35 U.S.C. 112, second paragraph

Claims 8 and 18 were rejected under 35 U.S.C. §112, second paragraph, because there is allegedly insufficient antecedent basis for the language "the conversion area" in line 3 of these claims. Claims 8 and 18 have been amended to change "the conversion area" to --a conversion area-- to obviate the §112(2) rejection.

Withdrawal of the rejection under §112, second paragraph, is respectfully requested.

Claim Rejections- 35 U.S.C. §103

Claims 1-3, 5-8, 10-13, 15-18 and 20 were rejected under 35 U.S.C. §103(a) as being unpatentable over **Honda et al.** (US 2002/0178328) in view of **Smith** (USP 6,347,359). For the reasons set forth in detail below, this rejection is respectfully traversed.

Initially, it is noted that independent claims 1 and 11 have been amended to clarify the invention. More particularly, independent claims 1 and 11 have been amended to indicate that the control unit reads out the data from said plurality of physical disk devices to said cache memory, and writes the data which was read out to said cache memory to said plurality of physical disk devices ***in an active status***.

The Present Invention

The present invention is directed to a RAID (Redundant Array of Inexpensive Disks) apparatus that increases the capacity of a RAID group or adds redundancy to the RAID group in an active status without shutting down the system. More particularly, the present invention is directed to a RAID apparatus and logical device expansion method for expanding the range of ***changing the RAID level*** in an active status, without changing the number of physical disks. Further, the present invention provides a RAID apparatus and logical device expansion method for ***increasing the capacity of the RAID group*** without changing the RAID level in an active status.

The Honda et al. reference

Honda et al. discloses a control method for processing an access request from a host computer in a RAID1 storage system.[1] More particularly, **Honda et al.** teach a storage

[1] The RAID1 disk array device stores duplicated data on two disk devices and allows data to be read from or written to one of the disk devices even when an error occurs in the other disk device in the redundant configuration and data cannot be read from or written to that disk device.

subsystem 4 having a plurality of storage devices 1 (i.e., disk devices that store duplicated data to form a RAID1 storage subsystem) that share an access request transmitted from host computers 2 to the storage subsystem 4. Each storage device 1 checks whether or not it should process the access request, making it possible to eliminate the need for a controller for controlling the individual storage devices. See page 3, sections [0059]-[0063].

As set forth in the Office Action, page 5 and page 6, lines 1-3, the Examiner cites Figs. 20, 22, 27-28 and 30-33 of **Honda et al.** against the claims. These figures correspond to the fourth embodiment of **Honda et al.** discussed beginning in section [0198]. In accordance with the fourth embodiment of **Honda et al.,** each storage device of the storage subsystem checks if it should process an access request based on (1) control information (cooperation control information) for allowing a plurality of storage devices to cooperate with each other to process an access request and (2) access request information from the host computer to the storage subsystem. See section [0199].

As shown in Fig. 20, the fourth embodiment of **Honda et al.** is a data processing system including a storage subsystem 4 having multiple storage devices 1 connected directly to a host computer 2 via an interface 3 (see section [0204]). A buffer 12 temporarily stores data transferred between the disks 11 of the storage devices 1 and the host computer 2. A main controller 10 controls all the components. See section [0205].

Further, **Honda et al.** disclose RAID configuration management information that is provided for each storage device 1 and includes RAID level information, a redundant data

management size, and information on the number of data disks/number of redundant data disks. See sections [0213] and [0303].

A significant feature of the **Honda et al.** system appears to be the use of cooperation control information 29 that is stored in each storage device 1 when an access request is issued from the host computer 2 to the storage subsystem 4. See, e.g., section [0210]. In summary, the cooperation control information 29 and access request information 26 allows each of the storage devices 1-1 to 1-N to determine if it should process the an access request. See, e.g., sections [0237] and [0245].

Differences between the Presently Claimed Invention and Honda et al.

It is respectfully submitted that the **Honda et al.** system is fundamentally different from the present invention. Specifically, the present invention is related to changing the RAID configuration (e.g., changing the RAID level from RAID 5 to RAID 0+1, or changing the number of disks). Unlike the present invention, the **Honda et al.** system does not change the RAID level or number of disks, and instead is related to cooperation between storage units processing access requests, thus eliminating the need for a controller controlling the individual storage devices. See discussion, e.g., in section [0062].

Thus, **Honda et al.** do not disclose or suggest "a table for storing old RAID configuration definition information which defines at least an old RAID level and a number of old logical devices, and new RAID configuration definition information which defines at least a new RAID level and a number of new logical devices," and a "control unit [that] reads out the

data from said plurality of physical disk devices to said cache memory according to the RAID logical unit mapping based on said old RAID configuration definition of said table, and writes the data which was read out to said cache memory to said plurality of physical disk devices according to the RAID logical unit mapping based on said new RAID configuration definition of said table," as recited in claim 1 (and corresponding method claim 11).

The Examiner apparently recognizes that **Honda et al.** do not disclose the above-noted claimed elements. Specifically, on page 3, lines 3-6 of the Office Action, the Examiner states "Honda does not teach that a new RAID configuration definition information which defines at least a new RAID level and a number of new logical devices and writes the data according to the RLU mapping based on said new RAID configuration." Further, it follows that if **Honda et al.** do not disclose the new RAID configuration information, then **Honda et al.** can not disclose the claimed control unit which writes data to the physical disk devices based on the new RAID configuration.

The Smith et al. reference

The Office Action relies on **Smith et al.** to teach the features missing from **Honda et al.** In particular, the Examiner asserts that **Smith et al.** teach the new RAID configuration definition information (see Office Action, page 6, lines 7-13).

Smith et al. disclose a method for reconfiguring RAID data storage systems that attempts to optimize the reconfiguration process. More specifically, as described in the Abstract, **Smith et al.** includes an array controller in a disk drive array that examines an original configuration of a disk drive array (source configuration) and a desired configuration (destination configuration) to

determine if the reconfiguration process can be optimized. The disk drive controller determines that the reconfiguration process can be optimized if a combination of changes to the system parameters and possible rebuilding operations can replace a migration process.[2]

Smith et al. teaches that the RAID system is reconfigurable. Specifically, the RAID system may be reconfigured to change the number of disks and the type of disks in the disk array. Other parameters, such as RAID level, strip size and stripe size may also be changed (parameters describing the number and type of disks, RAID level, strip size and stripe size are stored in reserved areas 114 of each disk(see col. 4, lines 55-57)).

The reconfiguration process of **Smith et al.** involves an initial phase where the RAID system is physically or logically reconfigured (i.e., by adding or subtracting disks 104 or by changing parameters stored in reserved storage areas 114). See column 4, lines 50-64. The initial phase is followed by a second phase where data is migrated to reflect the reconfiguration (see col. 4, lines 62-65).

However, **Smith et al.** does not disclose or suggest the claimed "a ***table*** for storing old RAID configuration definition information which defines at least an old RAID level and a number of old logical devices, and new RAID configuration definition information which defines at least a new RAID level and a number of new logical devices," and "***control unit*** [that] reads out the data from said plurality of physical disk devices to said cache memory according to the RAID logical unit mapping based on said old RAID configuration definition of said table, and

[2] **Smith et al.** defines the "migration process" as involving "copying each data bit from its pre-configuration location to its post-configuration location." See col. 2, lines 48-60 of **Smith et al.**

writes the data which was read out to said cache memory to said plurality of physical disk devices according to the RAID logical unit mapping based on said new RAID configuration definition of said table," as recited in claim 1 (and the similar features recited in method claim 11).

Specifically, according to **Smith et al.**, first it is determined if reconfiguration can be performed by changing parameters stored in the reserved storage areas 114 of each disk, without the need for data migration (see, e.g., col. 5, line 63 - col. 6, line 2). Moreover, if data migration is required, then an array controller 106 invokes a data migration routine to perform the data migration required to reconfigure the source configuration to the destination configuration (see, e.g., col. 5, lines 42-46).

However, **Smith et al.** is silent with respect to a table storing both old and new RAID configuration information. Although **Smith et al.** indicates that each disk has a reserved storage area 114 storing parameters (i.e., RAID level, strip size and stripe size) that may be changed, there is no teaching of storing a table with both the old and new configuration data.

Further, **Smith et al.** is silent with respect to how data migration is performed. **Smith et al.** only teach that data migration is performed if the reconfiguration cannot be performed by simply changing parameters stored in the reserved storage areas, and teaches no specifics of this migration. **Smith et al.** does not disclose or suggest a control unit that reads data from physical disks to cache memory according to RLU mapping based on an old RAID configuration of the table, and writes data from the cache to the physical disks according to RLU mapping based on a new RAID configuration of the table.

Therefore, the **Smith et al.** reference does not alleviate any of the deficiencies of **Honda et al.** and the combination of references does not result in the invention as recited in claims 1 and 11. Furthermore, it is submitted that each of the dependent claims are allowable by virtue of their dependency on claims 1 and 11.

In view of the above amendments and remarks, reconsideration and withdrawal of the rejection under §103 are respectfully requested.

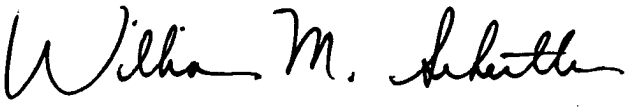
CONCLUSION

In view of the foregoing amendments and accompanying remarks, it is submitted that all pending claims are in condition for allowance. A prompt and favorable reconsideration of the rejection and an indication of allowability of all pending claims are earnestly solicited.

If the Examiner believes that there are issues remaining to be resolved in this application, the Examiner is invited to contact the undersigned attorney at the telephone number indicated below to arrange for an interview to expedite and complete prosecution of this case.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,
WESTERMAN, HATTORI, DANIELS & ADRIAN, LLP



William M. Schertler
Attorney for Applicants
Registration No. 35,348
Telephone: (202) 822-1100
Facsimile: (202) 822-1111

WMS/dlt